Not to be cited without the
permission of the author(s)[1]

Canadian Atlantic Fisheries
Scientific Advisory Committee

CAFSAC Research Document 87/ 26

Ne pas citer sans
autorisation des auteur(s)[1]

Comité scientifique consultatif des
pêches canadiennes dans l'Atlantique

CSCPCA Document de recherche 87/26

Scallop Fishing Grounds on the Scotian Shelf - 1986

By

G. Robert M.J. Lundy, and M.A.E. Butler-Connolly
Invertebrates and Marine Plants Division
Biological Sciences Branch
Halifax Fisheries Research Laboratory
Department of Fisheries and Oceans
Scotia-Fundy Region
P. O. Box 550
Halifax, N. S.
B3J 2S7

[1]This series documents the scientific basis for fisheries management advice in Atlantic Canada. As such, it addresses the issues of the day in the time frames required and the Research Documents it contains are not intended as definitive statements on the subjects addressed but rather as progress reports on ongoing investigations.

Research Documents are produced in the official language in which they are provided to the Secretariat by the author(s).

[1]Cette série documente les bases scientifiques des conseils de gestion des pêches sur la côte atlantique du Canada. Comme telle, elle couvre les problèmes actuels selon les échéanciers voulus et les Documents de recherche qu'elle contient ne doivent pas être considérés comme des énoncés finals sur les sujets traités mais plutôt comme des rapports d'étape sur les études en cours.

Les Documents de recherche sont publiés dans la langue officielle utilisée par les auteur(s) dans le manuscrit envoyé au secrétariat.

ABSTRACT

On the Scotian Shelf, scallop beds occur from Banquereau Bank to the east to the Lurcher Shoals at the approaches to the Bay of Fundy in a patchwork fashion. Historically, these grounds had never sustained production (measured by catch) for more than a few years until the 1980's when significant effort was diverted to these beds by both the Bay of Fundy fleet (vessels under 19.8m) and the deep-sea fleet (vessels over 19.8m). These grounds have traditionally been considered as second choice to the more proximate Digby grounds (Bay of Fundy fleet) or to the more lucrative Georges Bank (deep-sea fleet). Depleted stocks in the Bay of Fundy and a new management regime for the Georges Bank stocks (enterprise allocation) are changing the nature of the exploitation of the Scotian Shelf grounds from opportunistic to quasi-permanent. Catches from the Sable Island/Western Bank area were at an all-time high in 1986; reported catches from Browns Bank and German Bank by the Bay of Fundy fleet were questionable when the deep-sea fleet did not find exploitable quantities nor did stock surveys indicate abundance of commercial-size age groups.

Middle Grounds research survey indices show low quantities of older animals (age 5+) with no sign of pre-recruits. In the Sable Island/Western Bank area, the survey area covered in 1986 differed significantly from the previous year's coverage. One should not be disturbed by the lack of continuity in the survey results. Browns Bank stocks have still not recovered from successive recruitment failures.

Exploitation of Scotian Shelf scallop grounds is becoming a common occurrence, especially the Sable Island area. Although catch-rates are low, there are indications that recruitment takes place on a regular basis in the area.

RESUME

On trouve des bancs de pétoncles parsemés sur le plateau néo-écossais à partir du banc Banquereau à l'est jusqu'aux haut-fonds de Lurcher aux approches de la Baie de Fundy. Du point de vue historique, ces bancs n'ont jamais produit d'une façon soutenue d'après les captures, pour plus de quelques années jusqu'en 1980 et subséquemment lorsque la flottille de la Baie de Fundy (bâteaux de moins de 19.8m) et la flotte hauturière (bâteaux de plus de 19.8m) y ont appliqué un effort de pêche important. Ces régions avaient traditionellement été considérées comme second choix aux bancs de pétoncles de Digby plus proches (flottille de la Baie de Fundy) ou au banc Georges plus lucratif (flotte hauturière). Des niveaux de stocks très bas dans la Baie de Fundy et un nouveau régime de gestion sur le banc Georges (allocations par entreprise) sont en train de changer la nature de l'exploitation des stocks du plateau néo-écossais d'opportuniste à quasi-permanente. Les captures de la région de l'Ile de Sable et du banc Western ont atteint un niveau exceptionel en 1986. On doute de l'authenticité des prises de la flottille de la Baie de Fundy sur les bancs Browns et German; car la flotte hauturière n'y a pas trouvé de quantités exploitables et les inventaires de recherche n'indiquent pas d'abundantes classes d'âge de taille commerciale.

Les indices d'inventaires de recherche révèlent des quantités très basses d'animaux plus vieux (âge 5+) et aucune évidence de pré-recrues sur Middle Grounds. Dans la région de l'Ile de Sable l'inventaire de 1986 a couvert des aggrégrations différentes comparé à l'année précédente. On ne doit donc pas s'étonner du manque de continuité des résultats. Les stocks du banc Browns ne se sont toujours pas remis d'échecs successifs dans le recrutement.

L'exploitation des bancs de pétoncles sur le plateau néo-écossais est en train de devenir chose courante, surtout dans la région de l'Ile de Sable. Malgré des taux de capture peu élevés, il semble que ces stocks recrutent de façon régulière.

105-04723/

INTRODUCTION

This document updates the recent (1979 onward) profile of the scallop stocks and their exploitation on the Scotian Shelf from Robert et al (1986). Scallop grounds on the Scotian Shelf include from east to west (Fig. 1) Banquereau Bank, Middle Ground, the Sable Island area and Western Bank, Browns Bank (south side, north side: Tusket area), German Bank, Lurcher Shoals, the outer reaches of the Bay of Fundy (i.e. downstream from a line drawn across the Bay from Brier Island, N.S. to Grand Manan Island, N.B.), and Southwest Bank. The importance of the scallop fishery on the Scotian Shelf has been inversely related to the stock status of the more productive Georges Bank. The relative contribution of Scotian Shelf grounds and Saint Pierre Bank also exploited during 'lean' years on Georges Bank is given on Figure 2. In 1986, there has been a marked increase in the exploitation of scallop grounds in NAFO subareas 4V and 4W. It is not an indication of low stock abundance on Georges Bank however. Catch restrictions under an enterprise allocation management regime for Georges Bank which is first starting, shifted some of the traditional effort toward other grounds. The biological data base dealing with growth-rate and meat yield has been upgraded and revealed a great deal of biological heterogeneity of the Sable Island-Western Bank area.

During the annual stock survey, some explorative tows were made in the immediate vicinity of Sable Island to get a better idea of the composition of the benthic epifauna and scallop densities. A section of southeast Browns Bank was also monitored to follow up on an important year-class of juvenile scallops.

METHODS

Fishery Information

There are two sources of information to estimate the respective contributions of scallop fishing grounds on the Scotian Shelf. The Statistics Division, Department of Fisheries and Oceans, Halifax, compiles, on a yearly basis, landings by vessel size and by NAFO sub-subareas. Log information as to the origin of the catch provided by vessels is the other source. There are at times discrepancies between statistical and logged catches as NAFO sub-subareas are not tailored to the physical location of particular scallop beds and may cut a major scallop bed in two. This inadequacy of the statistical system was previously presented in Robert et al (1984).

All vessels (over 25.5 G.T. or 14 m L.O.A.) fishing the Scotian Shelf are required to keep logbooks in which daily fishing activities are recorded. Daily log records supply information on the catch and its location and fishing effort such as hours spent fishing, width of gear, and number of crew. Catch-rate estimates may be computed when complete effort data are provided with respect to the catch (Class 1 data). Total effort may be estimated according to the effort that generated the catch for which all information (location, hours fished, gear, etc.) is available. The productivity of a specific ground may also be established assuming that the catch with known location is representative of the total catch from that ground.

Scallop Fleets

Two components of the Canadian offshore fleet may drag for scallops on the Scotian Shelf. The deep-sea fleet, L.O.A. over 19.8 m is excluded from a 12 nautical miles zone near-shore and the Bay of Fundy. The Bay of Fundy fleet, L.O.A. between 14 and 19.8 m mostly (Bay of Fundy licensed vessels), may fish scallop beds in the Bay of Fundy and other areas of the Scotian Shelf.

Despite the different size of vessels, both fleets used an offshore-type scallop drag which width may vary from 2.4 to 4.9 m (8-16 feet). The Bay of Fundy fleet fishes only one drag at a time while the deep-sea fleet fishes two drags simultaneously, one on each side. These are slightly wider than the ones used by the Bay of Fundy fleet. On occasion, a Bay of Fundy vessel may use a gang of Digby-type drags.

Catch Sampling

Catch sampling information is available for the deep-sea fleet only. Port coverage varies greatly so that fishing areas like German/Lurcher off southwest Nova Scotia have not been given good coverage. Yarmouth and Saulnierville-based vessels are the main users of those grounds. Since the exploitation of scallop grounds on the Scotian Shelf was somewhat irregular until very recently, sampling of the catch is rather sporadic.

Survey Procedures on the Scotian Shelf

The catch distribution derived from log records for each particular fishing ground is used to randomly stratify survey stations. Catches from the deep-sea fleet over the year prior to the survey are considered. Annual surveys are carried out during May on a Government research vessel. Small scallop concentrations to the northeast and south, southwest of Sable Island were targeted for some exploratory tows. On Browns Bank, two Ten Minute Squares (TMS) (422653 and 422654) which had shown high concentrations of juvenile scallops in the past were also reevaluated. Very low levels of fishing activity in the German/Lurcher area suggested the near-absence of commercial size stocks in the area. The annual stock survey was not extended to German/Lurcher.

A 2.44 m wide New Bedford offshore dredge (75-mm ring size) lined with 38-mm stretch mesh polypropylene netting was the survey gear.

Tows were of ten minutes duration; distance towed was determined either from Loran C bearings, start-end of tow, or from continuous recording via a desk-top computer. Catches were later standardised to a tow length of 800 m. For each tow, the following data were recorded: 1) shell heights in 5-mm intervals for all live scallops and cluckers (shells with both valves still attached at the hinge); 2) tow location with Loran C bearings; 3) depth (m); 4) compass bearing for direction of tow; 5) duration of tow in minutes; 6) substrate type; 7) count of the number of vertical rings covered by the catch; and 8) total scallop catch as a round weight.

Relevant Biological Information

Biological information dealing only with growth-rate and meat weight on shell height allometry are given here. Biological data has been gathered since 1982 as part of an on-going study of somatic and gonadal growth cycles.

Some areas like the Sable Island-Western Bank area has been given better coverage, the commercial fleet bringing in samples, than other areas such as Browns Bank which has generated very little interest from the fleet lately.

Samples from 1982 to 1986 surveys and samples collected from the fleet up to 1985 were used in the analysis. Table 1 presents variables of von Bertalanffy growth curves and the number of scallop shells that have been ring-read for each area. It also gives the regression parameters for estimating meat yield as a function of shell height and the number of animals examined. In an attempt to reduce seasonal effects in yield conditions, samples collected at all times of the year have been included in the analysis to approximate a 'year round' value. The Sable Island area presents a wide range of depths (20-over 100 m) where scallop concentrations occur, leading to a great deal of heterogeneity in growth patterns. However, all data were pooled together to generate one equation for the area.

RESULTS

Scallop Fleets

Previous to 1984, over 100 vessels from the deep-sea fleet and the Bay of Fundy fleet were exploiting scallop grounds on the Scotian Shelf (Table 2). This activity declined during 1984, 1985 to increase again in 1986.

For both fleets, the Scotian Shelf fishery is not a feature as permanent as the Georges Bank fishery for the deep-sea fleet and the traditional scallop grounds within the Bay of Fundy for the Bay of Fundy fleet. Because of a new management regime (enterprise allocation) for the Georges Bank stocks in 1986, it appears that the deep-sea fleet is shifting some of the traditional effort to scallop grounds on the Scotian Shelf in NAFO subareas 4V and 4W. Catch-rates in NAFO 4W were not outstanding (especially compared to Georges Bank rates). The Bay of Fundy traditional fishing areas are presently at a very low level of abundance of commercial size stocks and the Bay of Fundy fleet has moved away from the Bay itself to make numerous fishing trips to Georges Bank and the western Scotian Shelf.

To give methodical coverage to all fishing areas (Fig. 2) (from east to west), each area is looked at with respect to: a fishery profile, an estimate of its productivity in terms of distribution of scallop beds and abundance, catch sampling, and survey results.

Banquereau Bank

Historically speaking, Banquereau Bank (NAFO subarea 4V) has never been reported as a scallop-producing area, catches averaging less than 10 t per year (Table 3). It is a natural geographical extension of Sable Island Bank to the east. It might therefore not be surprising that since the Sable Island area has produced such high landings in 1986, highest landing ever are reported from Banquereau Bank. These catches have also originated from TMS on Banquereau Bank adjacent to Sable Island Bank. High effort values correspond to the 1986 catch levels and catch-rates which were moderate decreased appreciably. Although exploitation had been light thus far the fishery performance does not indicate the presence of an important stock biomass.

Middle Ground

Middle Ground is a shallow bank of which 500 square nautical miles would have commercial densities of scallops. Its fishery characteristics are found in Table 4. Scallop production has been fairly sporadic with a 100 % increase in catches from 1985 to 1986 although catch-rates have gone down by 33 %. Figure 3 shows the gradual intensification of exploited grounds from 1980 on.

Sampling of the catch (Table 5) indicates that a wide range of meats are shucked (4-62 g) with a relatively large mean weight. This profile varies little between years.

Stock surveys (tables 6-8) have shown low abundance of scallops at age except for the first survey in 1983. There is also no sign of prerecruits in the lined gear. Consistently low stock levels rank Middle Ground as a marginal scallop fishing area.

Sable Island/Western Bank

When the deep-sea fleet began to fish scallop grounds in the Sable Island area in 1980, it confined itself to a small area of Western Bank, at the edge of the continental shelf within the 100-m isobath (Fig. 3). Gradually, fishing activities extended their range not only

along the edge of the shelf (in a northeasterly direction) but also over Western Bank, Sable Island Bank, and in the immediate vicinity of Sable Island up to Banquereau Bank (NAFO sub sub-areas 4Wf, g, h, j, l, and u designated here under the label of SA 4Wj). Annual catches have been low (Table 4) except for a 3 times increase from 1982 to 1983 and a sharp, 10 times increase from 1985 to 1986. High 1986 catches correspond to the highest effort values observed. Catch-rate values have always been low. Despite the extremely high effort expended in 1986, CPUE has dropped by about 25 %. It appears that exploitation of more distant scallop grounds contribute to sustain catch-rates although at a low level.

The mean weight of scallop meats shucked has decreased considerably in 1986 (Table 5) to 15 g, with a very wide range, from 2 to 79 g. About 50 % of the catch was scallops between 7 and 10 years of age, a fair mix of year-classes but the growth pattern of this area is complex. Scallop concentrations are dispersed over such a wide area that they encounter quite a diversity of environmental conditions and habitats.

Latest survey results show a substantial decrease in scallop abundance compared to the 1985 results (Tables 6, 9 and 10). The 1985 survey had detected significant numbers of prerecruits; prerecruits abundance is extremely low in 1986. However, the catch-stratified surveys of 1985 and 1986 covered distinct, non-overlapping areas (Fig. 4). The concentrations of juvenile scallops encountered in 1985 are limited in distribution to a band along the 100-m isobath for about 120 nautical miles. Other scallop beds in the area are not as prolific. Exploration tows near Sable Island did not discover any appreciable quantities of scallops.

Browns Bank/Tusket Area

When commercially important, scallop aggregations are found along the southern edge of Browns Bank (NAFO sub-subarea 4Xp) around the 100-m isobath and on the northern side of Browns Bank (Tusket, NAFO sub-subarea 4Xo) but in much deeper waters.

These scallop beds are exploited by both fleets, the deep-sea fleet landing more than the Bay of Fundy fleet except this past year (Tables 11 and 12). Despite discrepancies between statistical landings and logged catches, the scallop production from the Browns Bank area has decreased erratically; the same may be said for catch-rates until 1985. From then on, the deep-sea fleet CPUE shows a modest recovery while the Bay of Fundy fleet CPUE rises sharply. However, these last values may be non-representative. Figure 5 maps the productivity on a TMS basis.

The meat weight distribution in the catch (Table 13) varies greatly on an annual basis but the percentage examined is too small to draw any conclusion. Browns Bank catches have not been sampled in 1985 - 1986.

Survey characteristics are given in Tables 14-16. Previous surveys had found high concentrations of juveniles. The 1986 survey did not find signs of juveniles nor any improvement in the extremely low numbers of recruited scallops. Such results were reached despite an exploratory stratum to target the particular TMS areas where juvenile concentrations had been observed in past surveys. We reported last year (Robert et al 1986) on the very heavy mortality rates experienced by possibly 3 successive year-classes of scallops on the southern edge of Browns Bank. The stock will remain in a somewhat collapsed state due to the massive disappearance of year-classes at the juvenile stage, the lack of older animals in any quantity and the absence of prerecruits during the last survey.

German Bank/Lurcher Shoals and the Outer Reaches of the Bay of Fundy

NAFO sub-subarea 4Xq includes German Bank and the lower half of the Lurcher Shoals (up to latitude 44 degrees North); the upper half of Lurcher Shoals is part of sub-

subarea 4Xr. Statistical landings and logged catches for both fleets (Tables 17 and 18) diverge for these respective areas illustrating the misrepresentation resulting from the statistical areas boundaries as presently set. Biological differences exist between German Bank and Lurcher Shoals; growth-rate being slower on German Bank relative to Lurcher Shoals and the outer reaches of the Bay of Fundy.

During the recent exploitation of this area, the amount of fishable stocks steadily declined from its initial levels until 1985 (Table 17). Catch-rates were also following the same trends. A slight reversal of the downward trend appears to take place in 1986. The deep-sea fleet did not fish here at all; the Bay of Fundy fleet took relatively small quantities but at catch-rates similar to the high values encountered in 1979. At certain times the production of Lurcher Shoals has been comparable to the production of some TMS on Georges Bank (Fig. 5). Sampling of the catch (Table 18) has been scanty or did not take place.

The last survey results had indicated the presence of large old scallops and that their abundance was declining. Very low levels of fishing activity took place in 1985-86. The annual stock survey did not extend to the German/Lurcher area in 1986.

Exploitation of scallop grounds in the outer reaches of the Bay of Fundy has been decreasing after the landing pulse of the early 1980s (Table 19). Catch-rates have behaved similarly. Landings by both the Bay of Fundy and the deep-sea fleets have been minimal in 1986. However the deep-sea fleet managed a catch-rate (0.458 kg/crhm) comparable to values obtained during the initial stages of the recent fishery of these scallop beds.

Southwest Bank

The deeper waters of NAFO subarea 5Yb are exploited on occasions although level of catches have not been significant. Small (less than 14 m) vessels from Grand Manan Island expend the most effort in this statistical area. (See Grand Manan stock evaluation for 1986.

DISCUSSION

Scotian Shelf Scallop Grounds - an Alternative

Prior to the late 1970s, Scotian Shelf scallop grounds in NAFO areas 4W and 4X had only been exploited sporadically and the available biomass could not sustain a fishery for any length of time. Recent fishing activities more particularly in NAFO subarea 4W have now been taking place on a regular basis for 7 years. There has even been a radical increase (10X) of scallops caught in the latest year of exploitation. However the performance of the 4W fishery was not as outstanding as the landing figures suggest, with rather low catch-rates. Nevertheless, it was an alternate option for the deep-sea fleet which is attempting to improve the yield both in terms of higher biomass and spread over a longer period of time of a relatively strong year-class of scallops presently recruiting to the Georges Bank fishery.

During 1986, scallop grounds in NAFO subarea 4X have been fished almost exclusively by the Bay of Fundy fleet. Survey results did not suggest at this point in time any scallop concentration of commercial size nor did the deep-sea fleet manifest interest in their exploitation. Landings from the Bay of Fundy fleet may be misleading and there is a strong possibility that catches reported from NAFO subarea 4X did not originate in this area. Depleted commercial stocks on the traditional fishing grounds of the Bay of Fundy have produced a major shift of the Bay of Fundy fleet effort to the productive beds of Georges Bank. The Bay of Fundy fleet fishes Georges Bank under a quota system but in quite a few

instances the fishery continued well beyond reaching the quota (May 20, 1986) and some landings got misreported.

Status Outlook on the Scotian Shelf

Depleted stocks of large, older scallops on Browns Bank and in the German/Lurcher area and the apparent lack of recruitment of younger year-classes preclude the resumption of important fisheries in these areas.

The Sable Island/Western Bank area offers better resilience to the heavy exploitation it has been subjected to as shown by the 1986 fishery performance. The 1985 survey had also located an area of juvenile scallops which, given growing opportunities could make a significant contribution to a future fishery.

REFERENCES

Robert, G., M.J. Lundy and M.A.E. Butler-Connolly 1984. Recent events in the scallop fishery of the Bay of Fundy and its approaches. Can. Atl. Fish. Sci. Adv. Comm. Res. Doc. 84/71, 41p.

Robert, G., M.J. Lundy and M.A.E. Butler-Connolly 1986. Scallop fishing grounds on the Scotian Shelf - 1985. Can. Atl. Fish. Sci. Adv. Comm. Res. Doc. 86/41, 43p.

Table 1.- Updated biological data on growth-rate and meat yield (year round values) for scallop fishing grounds on the Scotian Shelf. N = number of scallops examined.

	Growth	Yield
Middle Grounds	N = 417	N = 289
	H_∞ = 161.504mm	intercept = -10.752
	t_0 = 1.3360	slope = 2.890
	k = 0.1851	
Sable, Western Bank	N = 1,354	N = 1,112
	H_∞ = 142.303	intercept = -10.751
	t_0 = 1.3493	slope = 2.818
	k = 0.2053	
Browns Bank	N = 398	N = 420
	H_∞ = 114.046	intercept = -16.265
	t_0 = 1.3456	slope = 3.997
	k = 0.2636	

Table 2.- Number of vessels by fleet fishing scallop grounds on the Scotian Shelf as per log information.

Year	Bay of Fundy under 19.8m L.O.A.	Deep-sea over 19.8m L.O.A.	Total
1979	38	75	113
1980	37	75	112
1981	44	76	120
1982	45	75	120
1983	27	73	100
1984	29	50	79
1985	14	34	48
1986	32	55	87

Table 3.- Fishery characteristics for the Banquereau Bank area (NAFO 4V) for the deep-sea fleet. Landings and catches are in t of scallop meats. Landings are from Statistics Division, Fisheries and Oceans, Halifax. Effort pertaining to Class 1 catch only.

Year	Landings	Logged catches	Class 1 catch	Effort (crhm)	CPUE (kg/crhm)
1980	3.30	7.17	7.17	20,171	0.355
1981	0.00	-	-	-	-
1982	0.69	0.42	0.42	1,092	0.387
1983	5.37	3.26	3.26	7,343	0.444
1984	3.18	0.63	0.63	939	0.672
1985	0.24	N/A	N/A	N/A	N/A
1986	15.64	11.15	10.98	45,849	0.239

Table 4.- Fishery characteristics for the Middle Grounds area (NAFO 4We) for the deep-sea fleet. Landings and catches are in t of scallop meats. Landings are from Statistics Division, Fisheries and Oceans, Halifax. Effort pertaining to Class 1 catch only.

Year	Landings	Logged catches	Class 1 catch	Effort (crhm)	CPUE (kg/crhm)
1979	-	-	-	-	-
1980	3.65	1.42	1.42	5,434	0.262
1981	-	-	-	-	-
1982	72.39	62.09	61.12	122,106	0.501
1983	105.16	104.92	100.59	309,055	0.325
1984	11.90	9.94	8.34	47,585	0.175
1985	26.89	21.59	21.59	99,345	0.217
1986	51.27	51.28	50.46	345,552	0.146
		Fishery characteristics for Sable Island and Western Bank (NAFO 4Wj)			
1979	-	-	-	-	-
1980	60.99	50.48	50.48	219,987	0.229
1981	0.56	0.00	0.00	0	-
1982	64.10	61.40	61.40	243,779	0.252
1983	185.15	166.47	164.45	886,072	0.186
1984	71.30	64.65	63.58	370,231	0.172
1985	64.93	76.00	76.00	294,217	0.258
1986	618.35	585.26	551.88	3,070,138	0.180

Table 5.- Nature of the catch from NAFO SA 4W determined by the analysis of scallop meat weights.

	% catch examined	meat weight (g)			
	catch landed	mean	min	max	s.d.
Middle Grounds					
1983	0.0240	20.00	3.04	69.99	0.13
1984	0.0392	14.84	4.23	46.97	0.14
1985	0.0175	22.88	6.31	66.40	0.22
1986	0.0134	22.73	4.33	61.51	0.23
Sable Island/Western Bank					
1980	0.0133	9.46	3.87	22.11	0.04
1981	-	-	-	-	-
1982	0.0015	9.15	4.65	15.38	0.11
1983	0.0339	13.49	2.25	72.43	0.04
1984	0.0161	11.10	2.65	42.48	0.07
1985	0.0025	27.41	11.27	54.30	0.52
1986	0.0271	15.03	2.33	79.13	0.03

Table 6.- Number of survey stations in NAFO SA 4W by year and by stratum type.

Middle Grounds	1983	1984	1985	1986
low catch	4	8	5	4
medium	4	-	-	-
high	12	12	5	6
total	20	20	10	10

Sable/Western Bank	1983	1984	1985	1986
low catch	N/A	14	7	13
medium	N/A	13	25	42
high	N/A	13	8	10
exploratory	N/A	-	-	10
total		40	40	75

Table 7.- Average number of scallops at age caught in a lined 2.44m New Bedford offshore dredge, Middle Grounds.

	Age (years)										Mean	s.d.
	1	2	3	4	5	6	7	8	9	10+		
1983 stock survey												
low	0	0	0	0	1	0	0	0	0	0	2	2
medium	0	0	0	2	13	8	1	0	0	2	26	15
high	0	0	0	3	31	9	0	0	0	1	55	67
1984 stock survey												
low	0	0	0	0	2	1	2	1	0	0	8	10
high	0	0	0	0	2	6	4	2	1	2	17	16
1985 stock survey												
low	0	0	0	3	6	2	4	1	0	0	20	23
high	0	0	0	0	0	0	3	3	0	1	10	13
1986 stock survey												
low	0	0	0	0	0	0	0	1	1	3	7	7
high	0	0	0	1	0	3	6	4	2	2	17	10

Table 8.- Summary of average number of scallops at age caught for prerecruits, shell height under 75mm or age less than 5 years, and recruits, shell height over 75mm by catch stratum, Middle Grounds area.

	Age (years)		
	1-4	5-10	11+
1983 stock survey			
low	0	1	0
medium	2	23	1
high	3	40	1
1984 stock survey			
low	0	6	0
high	0	16	1
1985 stock survey			
low	3	13	0
high	0	6	1
1986 stock survey			
low	0	4	1
high	1	16	1

Table 9.- Average number of scallops at age caught in a lined 2.44m New Bedford offshore dredge, Sable Island - Western Bank area.

	Age (years)										Mean	s.d.
	1	2	3	4	5	6	7	8	9	10+		
1984 stock survey												
low	0	4	2	4	5	3	3	1	1	5	28	39
medium	1	22	6	3	8	6	4	1	1	4	60	63
high	0	5	5	6	10	9	3	3	2	3	46	39
1985 stock survey												
low	0	71	55	27	15	12	7	6	2	9	205	222
medium	0	9	15	16	7	6	6	5	2	7	74	59
high	1	59	112	40	33	24	6	4	2	0	281	181
1986 stock survey												
low	0	1	3	2	2	1	0	1	1	5	15	15
medium	0	2	2	4	2	2	1	1	1	6	20	30
high	0	1	0	1	1	1	1	2	2	6	13	9
exploratory	0	0	0	0	0	0	0	0	0	1	3	2

Table 10.- Summary of average number of scallops at age caught for prerecruits, shell height under 75mm or age less than 5 years, and recruits, shell height over 75mm by catch stratum, Sable Island - Western Bank area.

	Age (years)		
	1-4	5-10	11+
1984 stock survey			
low	10	14	4
medium	32	21	3
high	16	28	2
1985 stock survey			
low	153	43	8
medium	40	27	6
high	212	69	0
1986 stock survey			
low	6	5	5
medium	8	8	5
high	2	8	5
exploratory	0	0	1

Table 11.- Fishery characteristics for the Browns Bank - Tusket area (NAFO 4Xp and 4Xo) for the Bay of Fundy fleet. Landings and catches are in t of scallop meats. Landings are from Statistics Division, Fisheries and Oceans, Halifax. Effort pertaining to Class 1 catch only.

Year	Landings	Logged catches	Class 1 catch	Effort (hm)	CPUE (kg/hm)
1979	213.50	228.19	168.39	5,375	31.33
1980	48.39	38.83	5.79	3,181	1.82
1981	19.05	19.18	3.84	639	6.01
1982	1.25	6.98	3.92	1,294	3.03
1983	-	-	-	-	-
1984	0.47	-	-	-	-
1985	8.30	3.52	0.03	202	0.17
1986	46.26	35.53	21.50	966	22.27

Table 12.- Fishery characteristics for the Browns Bank - Tusket area (NAFO 4Xp and 4Xo) for the deep-sea fleet. Landings and catches are in t of scallop meats. Landings are from Statistics Division, Fisheries and Oceans, Halifax. Effort pertaining to Class 1 catch only.

Year	Landings	Logged catches	Class 1 catch	Effort (crhm)	CPUE (kg/crhm)
4Xo					
1979	0.00	13.70	13.70	21,964	0.624
1980	13.17	40.79	33.41	60,979	0.548
1981	0.36	1.40	1.40	2,219	0.632
1982	47.55	70.87	65.76	86,204	0.763
1983	42.70	53.11	44.96	78,613	0.572
1984	10.57	13.24	13.24	45,619	0.290
1985	0.00	0.84	0.84	2,155	0.389
1986	0.00	0.00	0.00	0	-
4Xp					
1979	73.05	77.90	76.62	145,118	0.528
1980	258.23	205.91	199.25	479,388	0.416
1981	24.98	12.86	12.65	19,578	0.646
1982	114.07	83.40	82.84	217,580	0.381
1983	63.32	34.83	33.46	135,526	0.247
1984	16.60	4.95	4.95	26,565	0.186
1985	6.93	15.54	15.54	36,413	0.427
1986	4.64	4.00	4.00	6,948	0.576

Table 13.- Nature of the catch from Browns Bank/Tusket area determined by the analysis of scallop meat weights.

	% catch examined	meat weight (g)			
	catch landed	mean	min	max	s.d.
1979	0.0022	16.29	4.01	58.66	0.18
1980	0.0195	10.54	1.37	87.46	0.04
1981	0.0080	35.75	13.71	55.37	0.35
1982	0.0020	16.39	2.90	47.13	0.18
1983	0.0000	-	-	-	-
1984	0.0062	21.98	6.46	68.63	0.51
1985	0.0000	-	-	-	-
1986	0.0000	-	-	-	-

Table 14.- Number of survey stations on both sides of Browns Bank ,NAFO Sa 4Xp to the south, NAFO Sa 4Xo to the north by year and by stratum types.

	1983	1984	1985	1986
low catch	16	2	2	4
medium	-	7	14*	14*
high	18	10	8	1
total	34	19	24	19

*exploratory

Table 15.- Average number of scallops at age caught in a lined 2.44m New Bedford offshore dredge, Browns Bank/Tusket area.

	Age (years)										Mean	s.d.
	1	2	3	4	5	6	7	8	9	10+		
1983 stock survey												
low	46	368	2	0	1	1	1	1	1	2	676	1068
high	59	248	1	0	0	0	1	2	3	10	416	969
1984 stock survey												
low	0	0	0	0	0	0	0	0	0	0	0	--
medium	3	94	53	6	3	0	0	2	3	14	209	280
high	3	58	0	0	0	6	12	9	4	4	118	184
1985 stock survey												
exploratory	3	244	0	0	0	0	0	1	2	14	286	328
low	0	0	0	0	0	0	0	0	0	0	1	0
high	0	1	0	0	0	0	0	0	0	2	6	6
1986 stock survey												
exploratory	0	1	0	0	0	1	3	2	1	5	15	14
low	0	0	0	0	0	0	0	0	0	1	5	0
high	0	0	0	1	0	0	0	0	0	1	2	0

Table 16.- Summary of average number of scallops at age caught for prerecruits, shell height under 75mm or age less than 5 years, and recruits, shell height over 75mm by catch stratum.

	Age (years)		
	1-4	5-10	11+
Browns Bank / Tusket 1983			
low	416	6	1
high	308	9	7
Browns Bank / Tusket 1984			
low	0	0	0
medium	156	11	11
high	61	34	1
Browns Bank / Tusket 1985			
exploratory	247	6	11
low	0	0	0
high	1	0	2
Browns Bank / Tusket 1986			
exploratory	1	8	4
low	0	0	1
high	1	0	1

Table 17.- Fishery characteristics for the German Bank/Lurcher Shoals area (NAFO 4Xq) for both fleets. Landings and catches are in t of scallop meats. Landings are from Statistics Division, Fisheries and Oceans, Halifax. Effort pertaining to Class 1 catch only. (In parenthesis, catches supported by sales slips only.)

Bay of Fundy fleet Year	Landings	Logged catches	Class 1 catch	Effort (hm)	CPUE (kg/hm)
1979	293.82	258.25	182.37	7,112	25.64
1980	113.72	89.91	65.96	6,485	10.17
1981	194.73	185.51 (46)	125.57	14,352	8.75
1982	99.06	119.11 (16)	78.11	12,348	6.33
1983	43.68	32.30 (6)	16.76	5,949	2.82
1984	11.07	32.90	25.29	7,660	3.30
1985	2.80	1.45	0.30	416	0.71
1986	23.94	34.62	22.41	1,085	20.66

Deep-sea fleet Year	Landings	Logged catches	Class 1 catch	Effort (crhm)	CPUE (kg/crhm)
1979	102.32	147.10	145.20	157,729	0.921
1980	1269.71	1132.69	1021.86	1,614,441	0.633
1981	379.69	207.63	188.78	318,221	0.593
1982	659.74	535.84	403.51	954,628	0.423
1983	587.76	465.88	420.45	1,092,569	0.385
1984	207.13	175.83	156.45	581,969	0.269
1985	33.76	16.60	15.91	46,295	0.344
1986	1.59	0.00	0.00	0	-

Table 18.- Nature of the catch from German Bank/Lurcher Shoals area determined by the analysis of scallop meat weights.

	% catch examined	meat weight (g)			
	catch landed	mean	min	max	s.d.
1979	0.0019	11.39	4.74	34.15	0.06
1980	0.0135	11.66	2.20	85.82	0.02
1981	0.0084	12.74	2.34	75.27	0.04
1982	0.0171	16.04	3.69	76.92	0.03
1983	0.0010	11.99	3.35	44.13	0.11
1984	0.0008	22.69	3.88	53.52	0.42
1985	0.0000	-	-	-	-
1986	0.0000	-	-	-	-

Table 19.- Fishery characteristics for the outer reaches of the Bay of Fundy (NAFO 4Xr) for both fleets. It is not possible to estimate landings from the Bay of Fundy fleet from this area; 4Xr statistical landings also include the traditional fishing grounds off Digby. Landings and catches are in t of scallop meats. Landings are from Statistics Division, Fisheries and Oceans, Halifax. Effort pertaining to Class 1 catch only.

Bay of Fundy fleet Year	Logged catches	Class 1 catch	Effort (hm)	CPUE (kg/hm)
1979	0.05	0.05	11	4.72
1980	135.31	119.05	9,881	12.05
1981	179.23	174.71	16,416	10.64
1982	161.25	155.06	20,626	7.52
1983	35.24	30.86	6,011	5.13
1984	2490	23.96	7,674	3.12
1985	9.71	9.61	2,814	3.42
1986	2.11	2.11	1,771	1.19

Deep-sea fleet Year	Landings	Logged catches	Class 1 catch	Effort (crhm)	CPUE (kg/crhm)
1979	-	-	-	-	-
1980	16.86	65.63	60.91	126,700	0.481
1981	2.53	47.59	44.37	111,596	0.398
1982	0.03	87.44	58.66	154,694	0.379
1983	13.02	83.76	70.26	205,023	0.343
1984	4.55	24.35	20.11	98,465	0.204
1985	1.48	5.73	4.08	16,702	0.244
1986	0.00	2.79	2.79	6,092	0.458

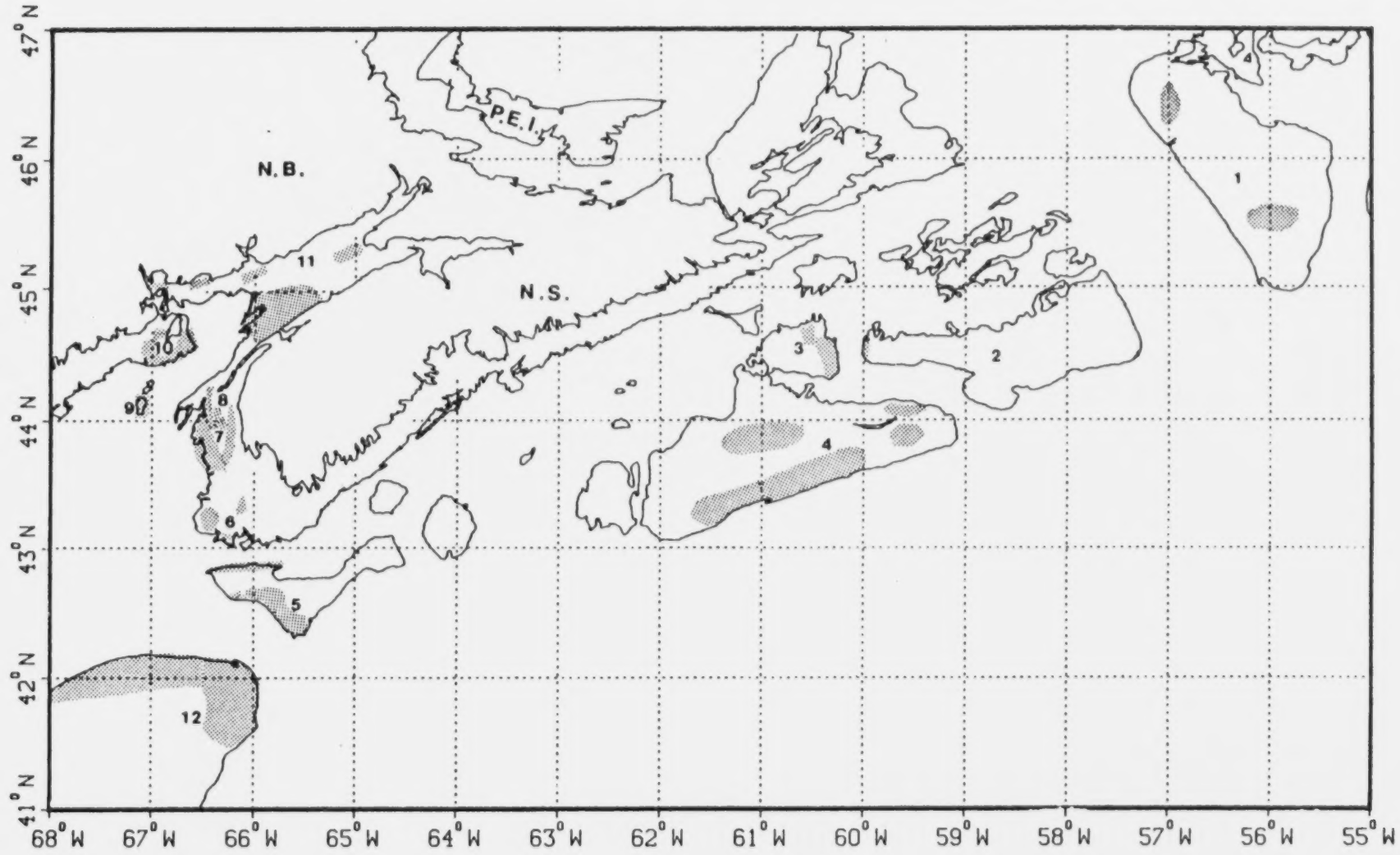


Figure 1.- Scallop fishing areas on the Scotian Shelf and St.Pierre Bank. The 100-m isobath is represented. Areas are in numerical order: (1) St.Pierre Bank; (2) Banquereau Bank; (3) Middle Ground; (4) Sable Island area; (5) Browns Bank; (6) German Bank; (7) Lurcher Shoals; (8) Outer reaches of the Bay of Fundy; (9) Southwest Bank; (10) Grand Manan area and (11) the Bay of Fundy area. Georges Bank (12) is also shown.

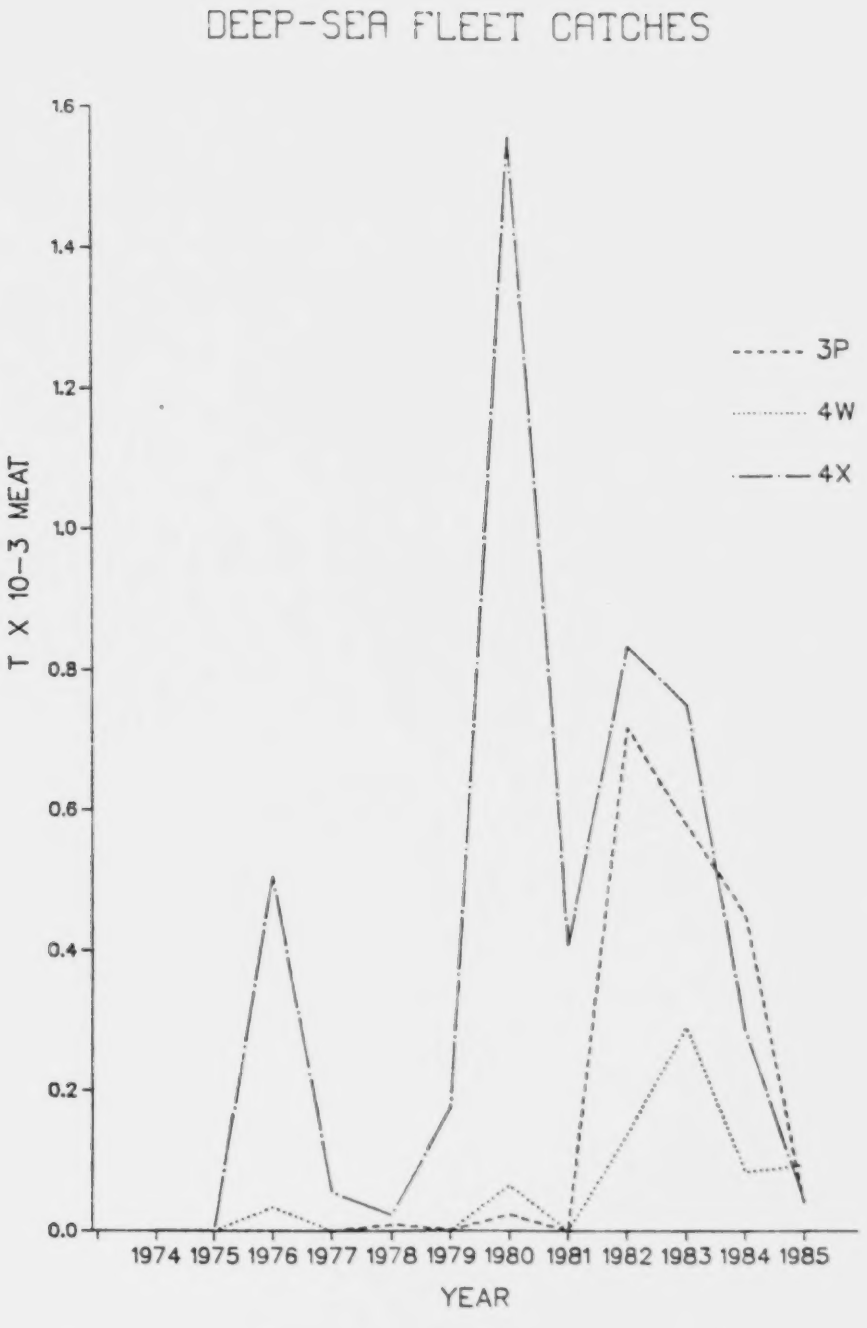
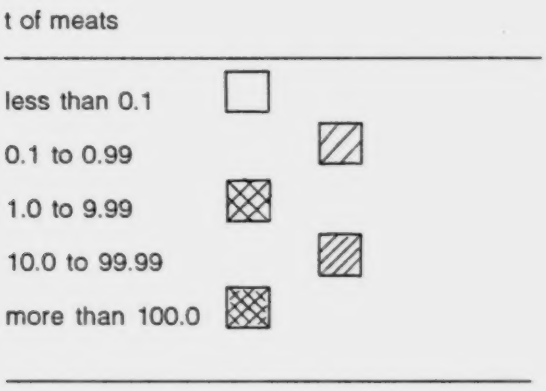


Figure 2.- Respective contributions (in t of scallop meats) of different NAFO sub-areas on the Scotian Shelf (4W and 4X) and St. Pierre Bank (3P) to the catches of the deep-sea scallop fleet.

Figure 3.- Productivity of scallop fishing grounds in NAFO SA 4W on a ten-minute square basis (TMS) according to the convention illustrated below. The 100-m isobath is illustrated.

Figure 5.- Productivity of scallop fishing grounds in NAFO SA 4X on a TMS square basis according to the following convention:



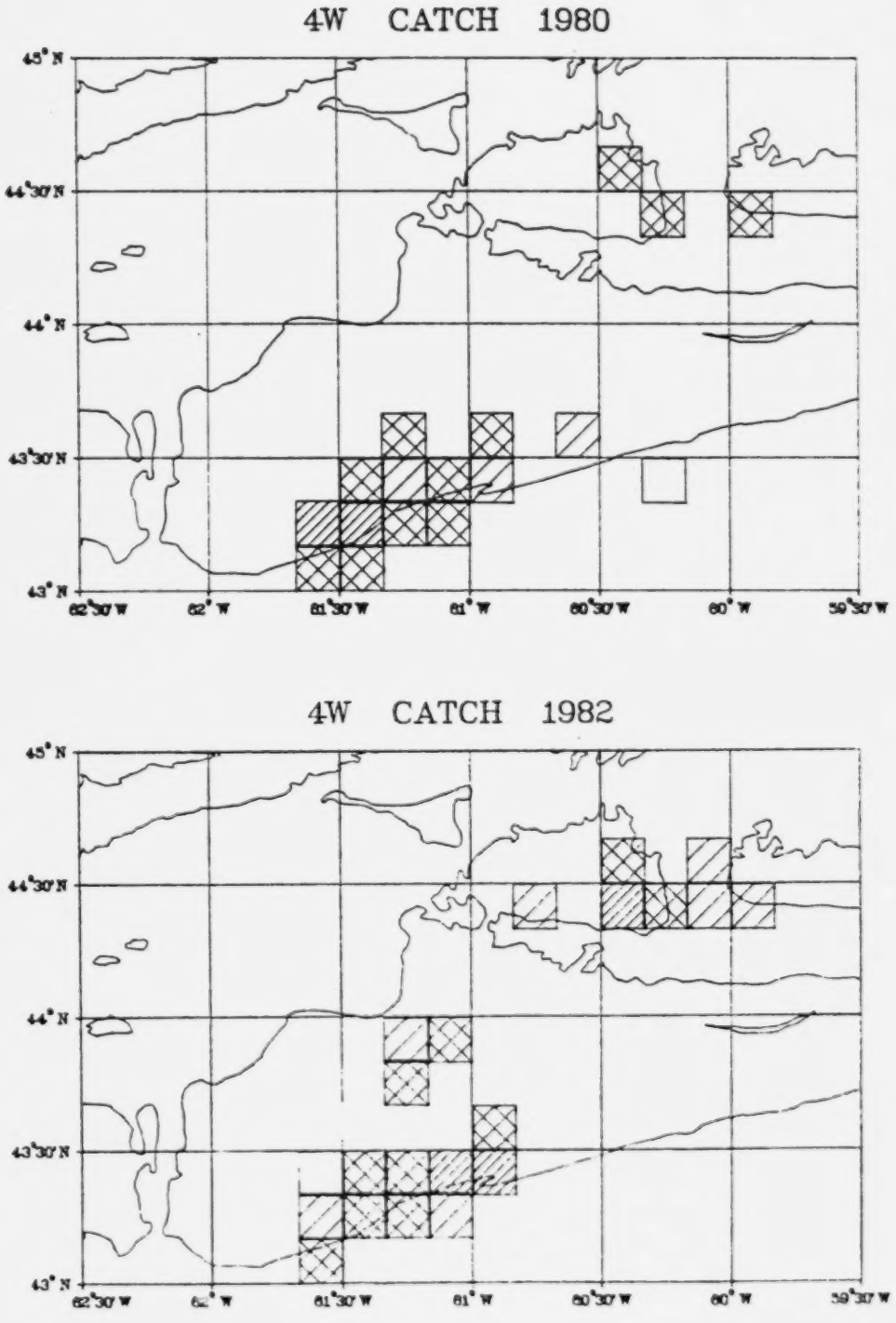
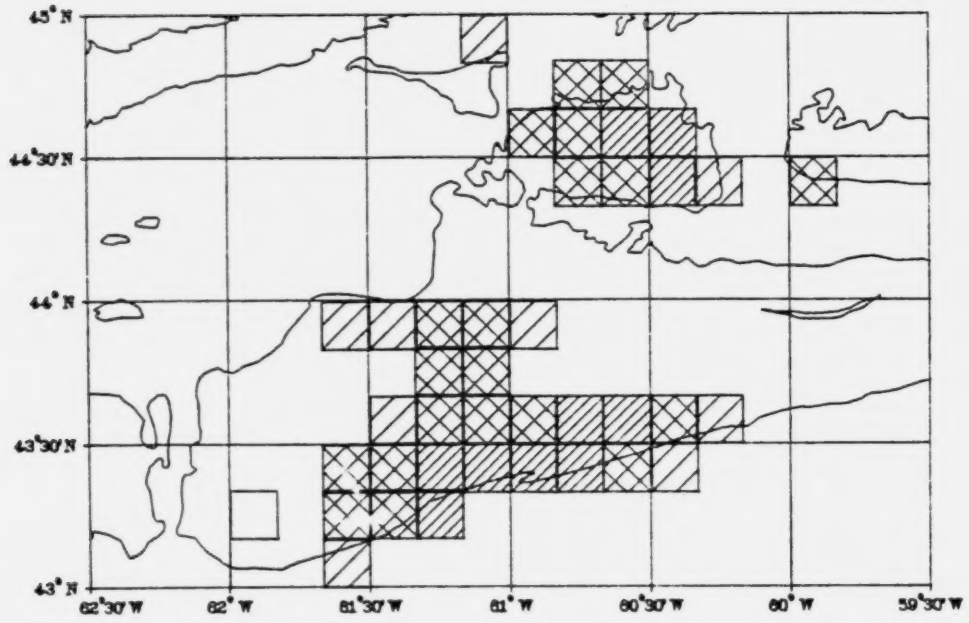

4W CATCH 1980
45° N
44°30' N
44° N
43°30' N
43° N
62°30' W
62° W
61°30' W
61° W
60°30' W
60° W
59°30' W
4W CATCH 1982
45° N
44°30' N
44° N
43°30' N
43° N
62°30' W
61°30' W
61° W
60°30' W
60° W
59°30' W

Figure 3.

4W CATCH 1983



4W CATCH 1984

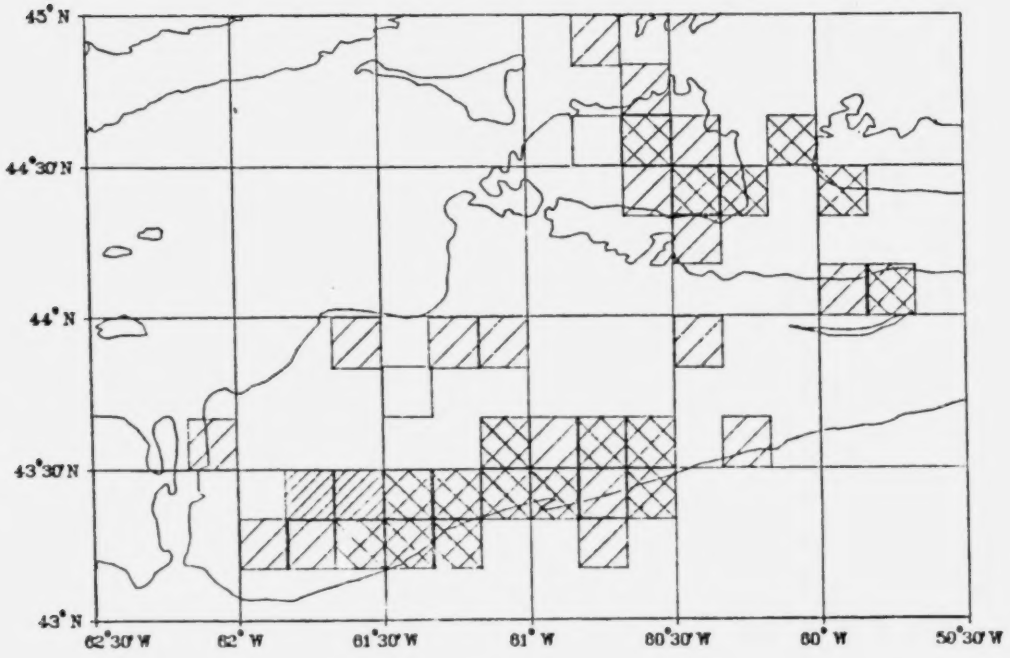
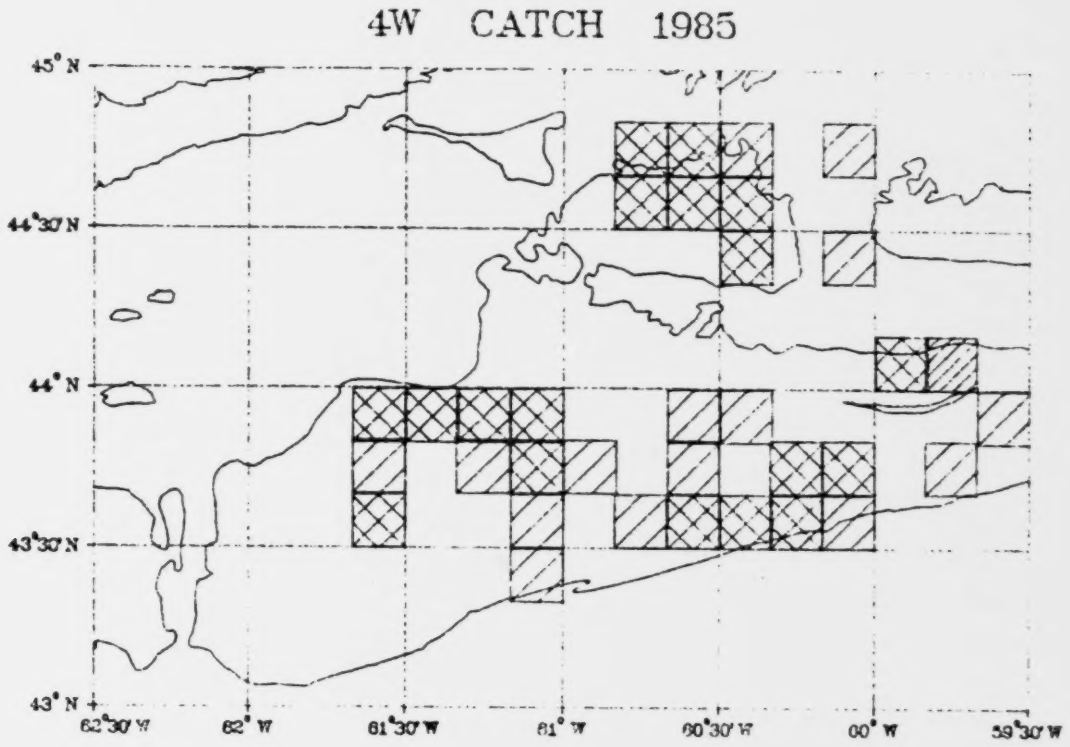


Figure 3.


4W CATCH 1985
45° N
44°30' N
44° N
43°30' N
43° N
62°30' W
62° W
61°30' W
61° W
60°30' W
60° W
59°30' W

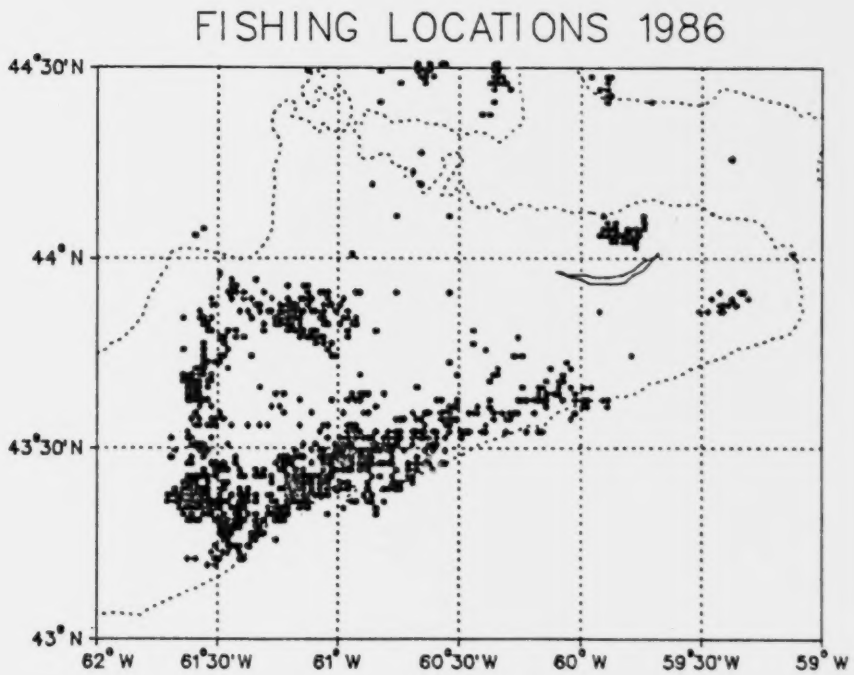

FISHING LOCATIONS 1986
44°30'N
44° N
43°30'N
43° N
62° W
61°30'W
61° W
60°30'W
60° W
59°30'W
59° W

Figure 3.

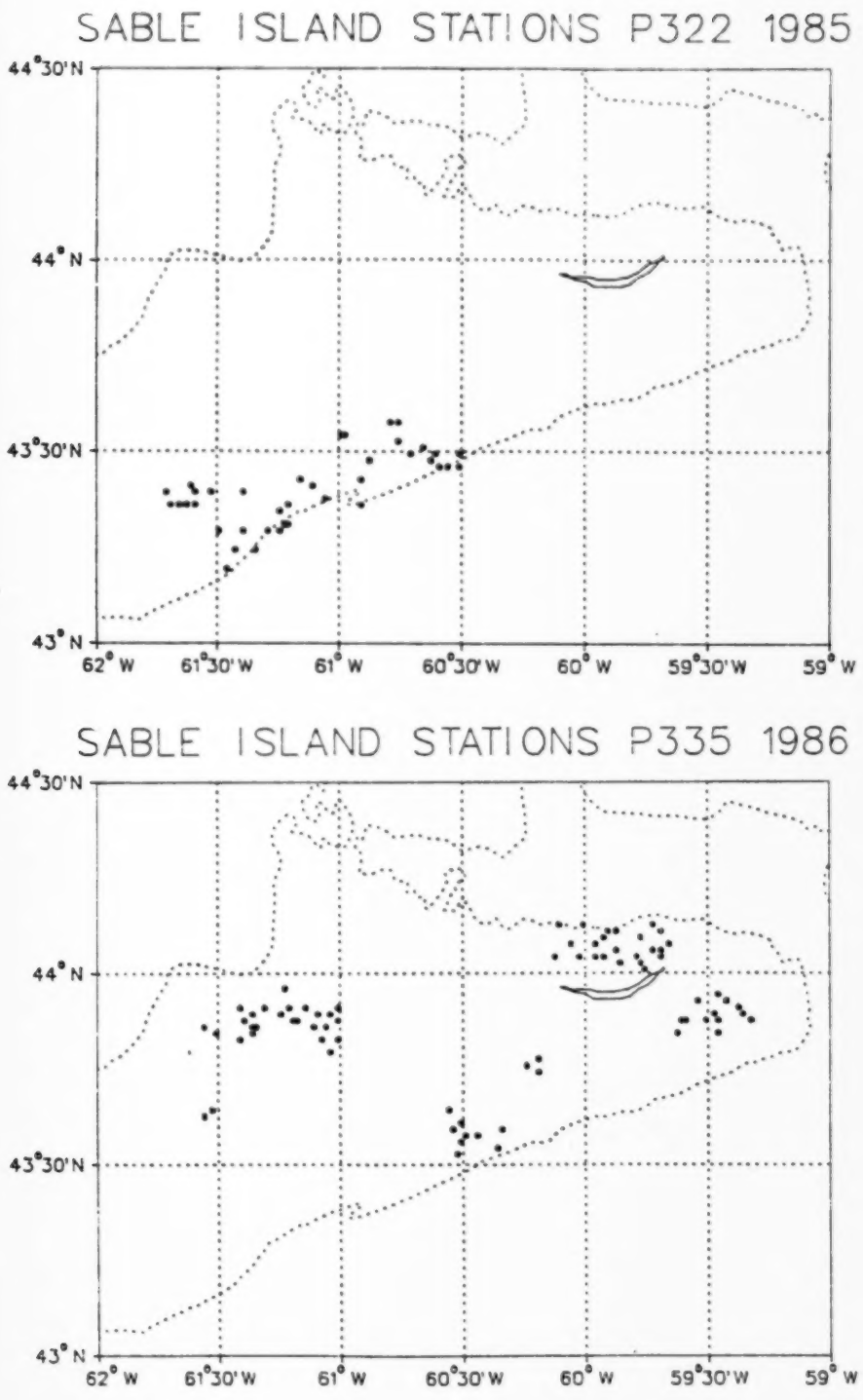
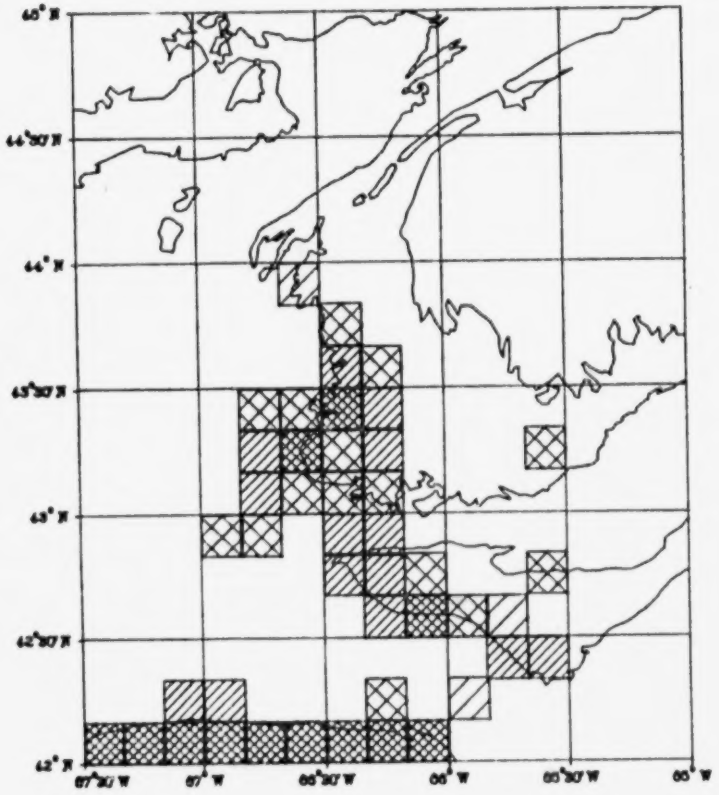


Figure 4.- Stock survey sampling locations for 1985 and 1986.

4X CATCH 1979



4X CATCH 1980

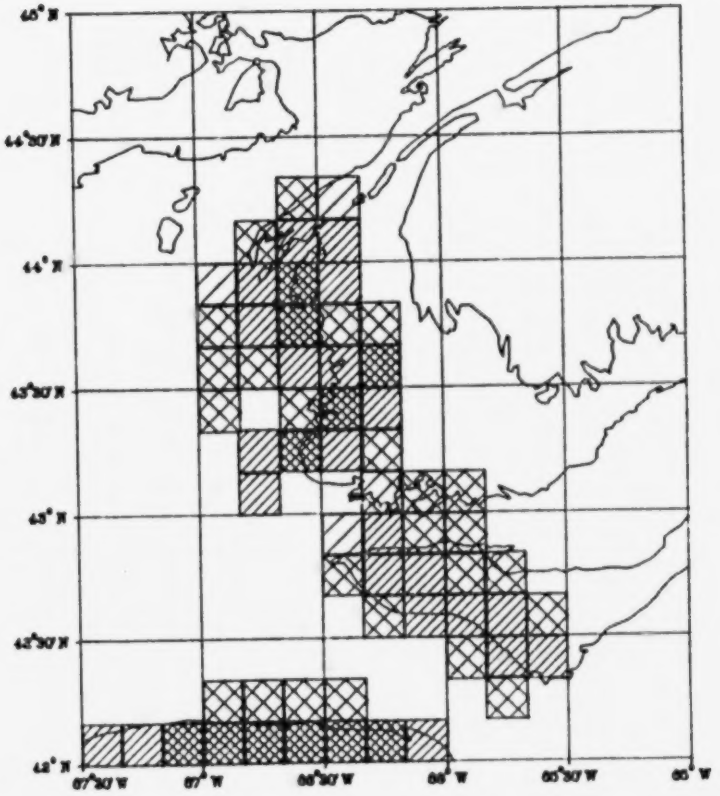


Figure 5.

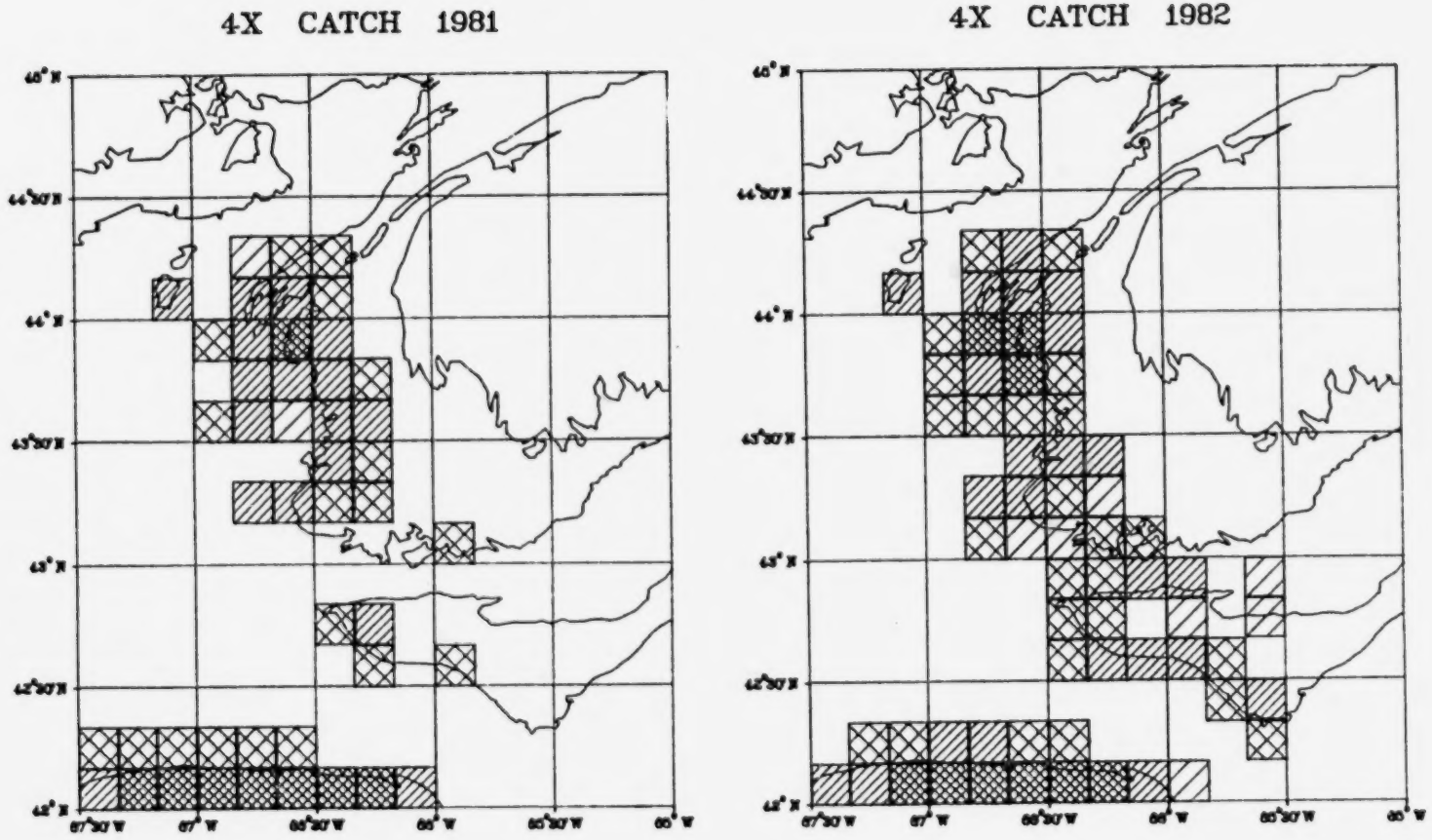


Figure 5.

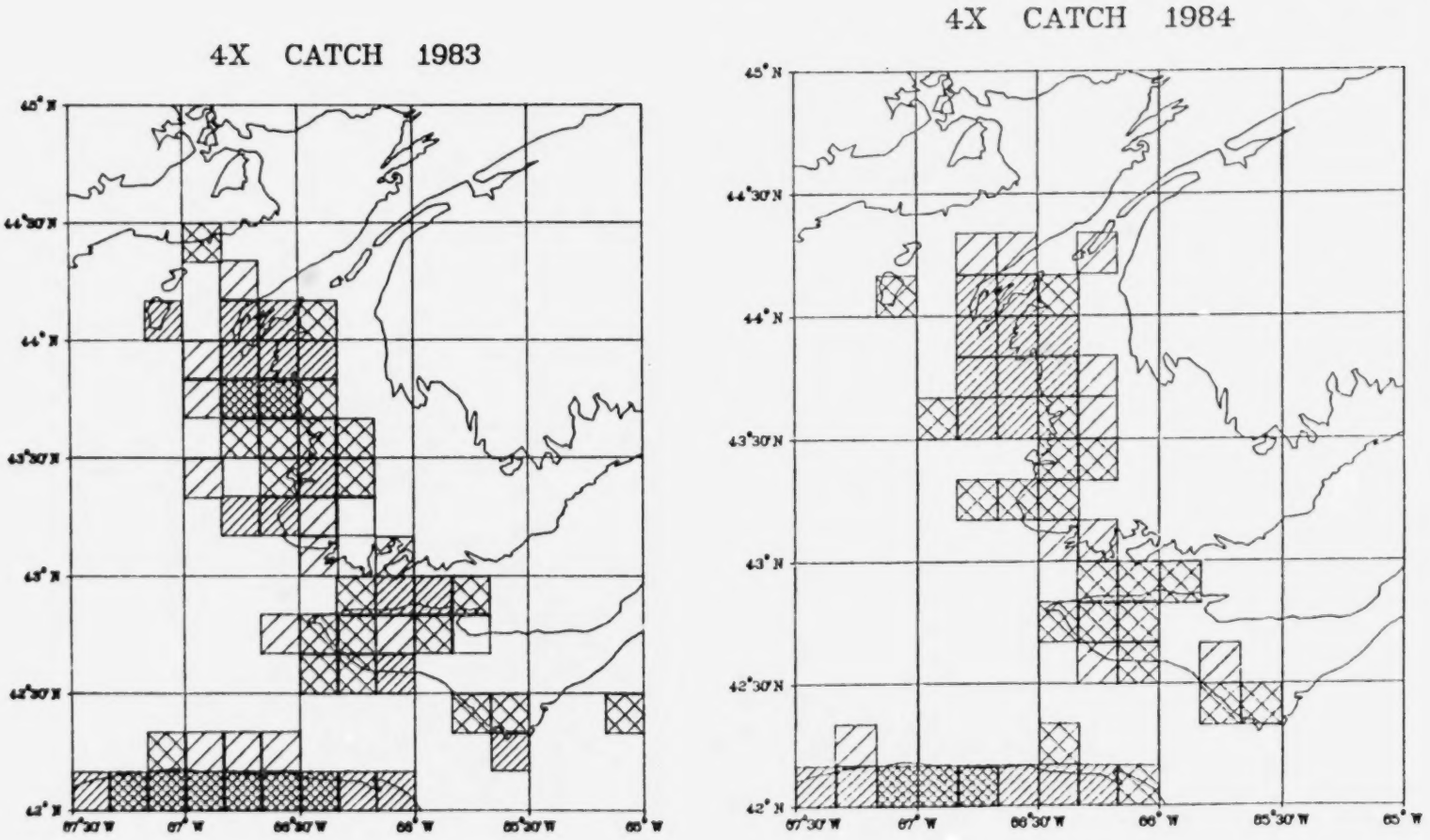

4X CATCH 1983
45° N
44°30' N
44° N
43°30' N
43° N
42°30' N
42° N
67°30' W
67° W
66°30' W
66° W
65°30' W
65° W
4X CATCH 1984
45° N
44°30' N
44° N
43°30' N
43° N
42°30' N
42° N
67°30' W
67° W
66°30' W
66° W
65°30' W
65° W

Figure 5.

4X CATCH 1985

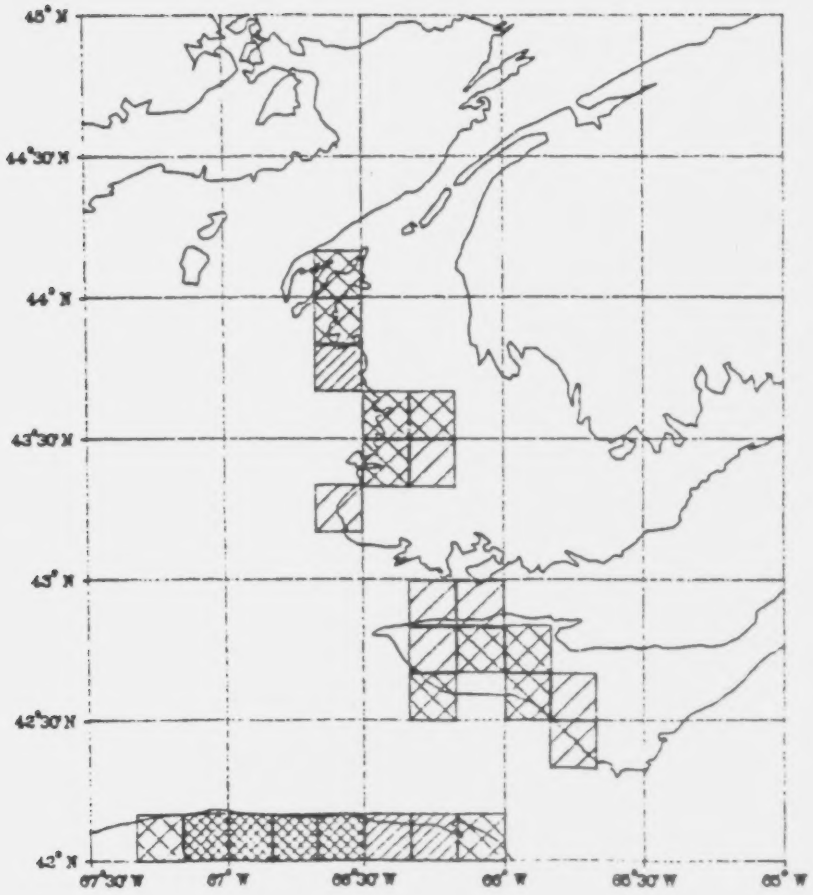


Figure 5.